

Economic Analysis

Vertebral Augmentation Versus Conservative Therapy for Emergently Admitted Vertebral Compression Deformities: An Economic Analysis

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Background: Vertebral augmentation (VA) performed on inpatients with painful osteoporotic vertebral compression fractures (VCFs) has been shown to facilitate discharge, decrease analgesic requirements, and improve pain.

Objective: The purpose of our study was to compare the overall cost, length of stay, and readmission data for patients hospitalized with painful osteoporotic VCFs, treated either medically or with inpatient VA.

Setting: A single academic medical center.

Study Design: Economic analysis

Methods: Patients admitted with VCF over a 30-month period were identified using ICD-9 codes. The total length of stay, hospitalization costs, average daily cost, and 30-day readmission rates were compared between those who underwent VA and those managed nonoperatively. A subgroup analysis was performed with an age matched group of controls as well. Two-tailed t-tests were used for statistical significance.

Results: Thirty-nine inpatients underwent VA; 61 levels were augmented. Their average age was 81.7 years. There were 209 patients who were treated nonoperatively for VCF. Their average age was 72.7 years, a significant age difference from the VA group ($P < 0.01$). The VA patients' average length of stay was 13.8 days, compared to 8.1 days in the medically managed group ($P < 0.01$). Average total costs were \$26,074 in the VA group and \$15,507 in the medically managed group ($P < 0.01$). The daily costs of admission were \$2,040 in the VA group and \$2,069 in the medically managed group ($P = 0.85$). The readmission rates related to VCF were 0% in the VA group; 5.2% in the medically managed group; and 7.7% in the age-matched control group. Of those who underwent VA, 43% experienced delays in care related to anticoagulation or medical comorbidities.

Limitations: The study is retrospective and uses billing data as a marker for total cost of care. The study does not account for cost differences between vertebroplasty and kyphoplasty.

Conclusion: Inpatient VA can be cost effective as demonstrated by the same daily cost between the VA and medically managed groups. Early identification and consultation can facilitate VA and rapid discharge. Anticoagulation issues and medical comorbidities can delay VA and lengthen hospital stays. Hospital admitted patients with painful osteoporotic VCF who are managed conservatively and discharged are at risk for readmission.

Key words: vertebral augmentation, osteoporotic vertebral compression fracture, vertebroplasty, kyphoplasty

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Osteoporotic vertebral compression fractures (VCFs) can be so painful and debilitating that they lead to inpatient hospitalization for pain management. Studies show that between 8% and 50% of acute VCFs may require inpatient care (1). The prevalence of osteoporotic VCFs may contribute to upwards of 150,000 hospitalizations annually (2). When managed conservatively with analgesics, prior studies have documented an average hospital stay of 6-10 days (3). In 1997, hospital admissions for VCFs accounted for 329,000 inpatient days at a cost of \$506 million. Of these, 40% were discharged to long-term care, with an additional 24.3% requiring follow-up care. Inpatient care for VCFs requires a lengthy hospital admission at a significant cost to society.

Vertebral augmentation (VA) has been shown to be a useful tool in the treatment of VCFs in the outpatient population, and has been studied extensively for outcomes as well as cost efficiency (4). The success of VA in the inpatient population has been studied as well and has shown that VA can facilitate a rapid hospital discharge, lead to long-term improvement in patients admitted for refractory pain, and lead to decreases in analgesic requirements (1). However, no specific study has evaluated the cost efficiency of this intervention specifically in the inpatient population admitted through an emergency department. The purpose of our study was to compare the overall cost, length of stay, and readmission data for patients hospitalized with painful osteoporotic VCFs treated medically or with inpatient VA at a single academic medical center.

METHODS

Institutional review board approval was obtained for the study. We performed a retrospective review of hospital charges from April 2008 through September 2010. All patients admitted with a diagnosis of osteoporotic VCF were identified based on ICD-9 diagnostic codes 733.13 (pathological fracture of vertebrae), 805.2 (closed fracture of dorsal vertebra without spinal cord injury), and 805.4 (closed fracture of lumbar vertebra without spinal cord injury). The subset of patients treated with VA during their hospitalization were identified based on ICD-9 procedural codes 81.65 (vertebroplasty) and 81.66 (kyphoplasty).

The total cost of admission was examined for each patient along with an average cost of admission, calculated by dividing the total cost for the hospitalization by the length of stay for that admission. A subgroup of age-matched controls were identified to correct for

any age-related health differences between the medically managed and intervention groups. Patients who underwent VA in the operating room were excluded in order to allow for internal controls. Additionally, this excluded patients who were admitted electively for a brief one-to-two day hospital stay solely for the purpose of VA. Lastly, those patients who underwent open surgical stabilization were excluded from the analysis.

Patients who underwent VA during their hospital stay were compared to those patients managed medically using a 2-tailed t-test for statistical significance, with a *P* value of 0.05 used to determine statistical significance. Differences in hospital length of stay, case mix indices, total cost of admission, daily cost of admission, 30-day readmission rates, and 30-day readmission rates related to VCF were compared.

All VA procedures were performed by a single, experienced operator in a fluoroscopy suite according to a standardized protocol. In order for inpatients to be seen, a VA consult must have been requested by the patient's primary physician. The consult was then performed by the operator, including a thorough history and physical, and a physical exam under fluoroscopy. All patients with medical comorbidities had been cleared prior to VA. Patients who were anticoagulated were required to correct their coagulation status per previously published literature (5). Patients with active infections were required to be completely treated prior to VA. Patients were also initially consulted by and examined by a spine surgeon. All patients were given information by all health care providers regarding treatment alternatives and given the time and opportunity to decide on their treatment plan.

RESULTS

A total of 39 patients were identified who had VA for osteoporotic VCF as inpatients during the study period. A total of 61 levels were augmented: 40 levels by kyphoplasty and 21 levels by vertebroplasty. Twenty-eight patients were women and 11 were men. They had an average age of 81.7 years. The medically managed group contained 209 patients during the same time period: 143 were women and 66 were men. They had an average age of 72.7 years. The age difference between the 2 groups was statistically significant (*P* < 0.01). To account for other comorbidities in this elderly population, the case mix index per patient was calculated and was found to be 1.98 in the VA group compared to 1.56 in the medically managed group (*P* < 0.01) (Table 1).

The total length of stay was compared between

the 2 groups. The average length of stay for the VA group was 13.8 days compared to 8.1 days in the medically managed group. This was statistically significant ($P < 0.01$).

In the VA group 13 patients (33%) were receiving anticoagulation therapy and required correction of their coagulation status prior to intervention. This delayed performance of the procedure by at least 5 days. Three patients (7.6%) required medical clearance for underlying infection, and 2 patients (5.1%) experienced delays related to further imaging requirements prior to intervention. In total, 43% of the patients in the VA group had a medical delay prior to the procedure. When corrected for these delays, the length of stay in the VA group was 11.7 days, still significantly greater than the 8.1 days in the medically managed group. There were no procedure-related complications in the VA group (Tables 2-4).

The total cost of admission was obtained from hospital billing data. The average total cost of admission for the VA group was \$26,074 compared to \$15,507 for the medically managed group ($P < 0.01$). The average cost per day in the VA group was \$2,040 compared to \$2,069 in the medically managed group ($P = 0.85$). The 30-day readmission rate for all medical conditions was 15.4% in the VA group and 12.4% in the medically managed group ($P = 0.35$). None of the readmissions in the VA group were related to VCF, however 5.2% were related to VCF in the medically managed group ($P = 0.05$). In the VA group 46% were discharged home, compared to 60% in the medically managed group ($P = 0.06$) (Table 2).

An age-matched control group was sub-selected to correct for the statistically significant age difference between the older VA group and all medically managed patients (Table 3). The age-matched control group had an average length of stay of 9.9 days, compared to 13.1 days for the VA group, along with lower total costs and daily costs. However, this age-matched group had a 23.1% 30-day readmission rate for all medical conditions. The readmission rate related to VCF in this group was 7.7% compared to 0% in the VA group ($P = 0.02$), indicating that this group may have been discharged prematurely.

A breakdown analysis of the total length of stay was performed. On average, 4 days elapsed between admission and consult by the interventionalist. Where possible, the consult was performed on the same day it was requested. From this point, another 4 days elapsed between the consult and the procedure. In total, 8 days

Table 1. *Demographic data.*

	VA	Medical Management
Number of Patients	39 (61 levels augmented)	209
Average Age	81.7	72.7
Men/Women	30/70	32/68
Case Mix Index	1.98	1.56

Table 2. *Comparison of VA and medically managed patients.*

	VA	Controls	P-Value
Length of Stay (LOS) (Days)	13.8	8.1	< 0.01
Corrected LOS (Days)	11.7	8.1	<0.01
Total Cost (\$)	26,074	15,507	< 0.01
Cost /Day (\$)	2,040	2,069	0.85
30-day Readmission Rate	15.4%	12.4%	0.35
VCF Readmission Rate	0%	5.2%	0.05
Home Discharge	46%	60%	0.06

Table 3. *Comparison of VA and age-matched medically managed controls.*

	VA	Age-Matched Controls	P-Value
Length of Stay (Days)	13.8	9.9	< 0.01
Corrected LOS (Days)	11.7	9.9	0.08
Total Cost (\$)	26,074	16,241	< 0.01
Cost /Day (\$)	2,040	1,718	< 0.01
30-day Readmission Rate	15.4%	23.1%	0.20
VCF Readmission Rate	0%	7.7%	0.02

Table 4. *Length of stay breakdown analysis.*

	VA	Trout, et al (1)
Total LOS	13	6
Admit – Consult	4	N/A
Consult - Service	4	N/A
Admit – Service	8	4
Service – Discharge	4	1.5
Delays in treatment (Anticoagulation, UTI, Family Discussions, Etc.)	43%	N/A

elapsed on average between admission and service. The average length of stay in the VA group decreased by almost 2 full days when correcting for delays in VA related to anticoagulation and medical contraindications. On average, patients were discharged 4 days after service, however the same patients with anticoagulation and medical comorbidities were discharged approximately 6 days postprocedure (Table 4).

Discussion

VA has become one of the primary tools to treat VCF. Previous studies have demonstrated the safety and effectiveness of VA on an inpatient population; VA is a therapeutic option for the treatment of VCF (1). The goal of this study was to compare the hospital course, in terms of overall cost, length of stay, and readmission rates, between medically managed and VA groups of patients with painful osteoporotic VCF.

The current study demonstrates that VA can be performed in the inpatient population without significantly increasing the daily cost of hospitalization.

Though the total cost of hospitalization was increased in the VA group, this was likely related to the longer lengths of stay in the group, and not the intervention. Though the study was not designed to determine the cause of the length of stay, this was not felt to be directly caused by VA for several reasons. The VA group was approximately 9 years older, with an average age of 81.7 compared to 72.7 in the medically managed group ($P < 0.01$). These older patients had an average of 3-4 significant comorbidities per patient. The case mix indices for these patients were evaluated and demonstrated an average case mix index of 1.98 in the VA group compared to 1.56 in the medically managed group. One prior study evaluating patients undergoing VA identified from a national database documented an average age of 78.2 years for those undergoing vertebroplasty, and 76.9 years for those undergoing kyphoplasty with an average of 1.3-1.6 comorbidities per patient (6).

Furthermore, the overall readmission rate for issues not related to VCF was 15.4% in the VA group and 7.2% in the control group ($P = 0.05$), further suggesting that the VA group had significantly more medical comorbidities. When comparing to an age-matched control group, the readmission rate rose to 23.1% in the medically managed group compared to 15.4% in the VA group ($P = 0.20$). Additionally, a prior study has demonstrated that VCF can facilitate a rapid hospital discharge, rather than prolong it (1). At our institution,

medical management with analgesics and bracing is considered the first line option for patients with painful VCF. Our service is usually consulted after orthopedic surgery or neurosurgery have already seen the patient. There were no readmissions in the VA group related to VCF, with a 5.2% readmission rate in the entire control group and a 7.7% rate in the age-matched control group. This becomes a significant cost contribution when considering that each admission in the control group cost \$15,507. In our hospital, this contributed to approximately \$170,577 in additional costs for those patients readmitted from the control group.

Upon review of our findings, it was noted that the length of stay in our study was more than double that published previously for inpatient VA (1). We broke down the hospital course in our patients and discovered that it took approximately 8 days between admission and VA (Table 4). Comparison with this prior study showed that the patients in their study were younger at an average age of 77.6 years. The issue of VA delays related to anticoagulation and medical clearance was not examined in the prior study. However, on average they performed VA within 4 days of admission, whereas in our study the average was 8 days. Rapid identification and treatment of inpatients will help facilitate their symptomatic improvements and realize greater cost-efficiency with VA. It has been suggested that a hospital-wide VCF treatment protocol and rapid correction of anticoagulation status could facilitate this. In theory, if patients without comorbidities were rapidly evaluated on the day of admission and had VA on the following day, they could be discharged 4-5 days later, achieving the same standard as the previously published data.

A limitation of this study is that it is retrospective in nature and focused on billing data. There was no specific subgroup analysis between vertebroplasty and kyphoplasty. However, studies have demonstrated similar costs between vertebroplasty and kyphoplasty when factoring in differences in length of stay (7). Clinical outcomes such as pain and analgesic use were not specifically documented in our study. Length of stay and readmission rates were used as a gross marker of clinical improvement. Lastly, the study was limited by the presumed difference in the VA and control groups, based on the statistically significant differences in age which is contradictory to previously published studies based on national data which demonstrated the average age of those undergoing kyphoplasty to be 1.3 years younger than those undergoing nonoperative management (8). Though this does limit direct comparison between

the groups, it supports the suspicion that in our institution VA is not considered a first line treatment for VCF. Since this study, an attempt has been made to further educate referring clinicians and residents through lectures on the role of VA in treating VCF.

CONCLUSION

In conclusion, inpatient VA can be a cost-effective treatment for painful osteoporotic VCF. Combined with the previously published data documenting its clinical efficiency, VA should be strongly considered as a first line treatment when appropriate for the treatment of

painful osteoporotic VCF in patients admitted through the emergency department. Early identification and consultation is a key to realizing the full potential of this treatment's cost efficiency. When necessary, patients admitted with painful VCF should undergo rapid transient correction of their anticoagulation status as soon as clinically feasible in order to avoid procedural delays. Lastly, there may be many inpatients with VCF who are not receiving VA who could possibly benefit from the procedure. Development of an institution-wide VCF protocol may help referring clinicians identify these patients and refer them appropriately.

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